Technology Corner

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IMPACTS OF ROAD SALTING ON WATER QUALITY

BACKGROUND

To promote highway safety, it is common in many states, including Utah, that pavement surfaces be kept "ice and snowpack free" during the winter months. One of the more common approaches used by maintenance forces is the application of a salt or sand-salt mixture to the pavement. This application raises the freezing temperature of water and melts the ice or snow pack. This can result in a portion of salt entering a water course or ground water. Sodium chloride (NaCl) and calcium chloride ($CaCl_2$) salts have ions that are less harmful than other salts and, in small amounts, will not be detrimental to either plants and animals. However, if applications are not properly managed, increased salinity could impact groundwater, streams, and lakes. To ascertain a better understanding of the impacts of deicing operations on water quality, a study was initiated by UDOT's Research Division. This study was conducted by Darwin Sorensen, Valton Mortensen & Randall Zollinger through the Utah Water Research Laboratory at Utah State University. The following tasks were undertaken:

1)Review the literature on road salting water quality effects and prepare a synthesis.

2) Survey other States deicing operations and on-going studies.

3) Perform analysis of groundwater and surface water quality data at selected locations in the Salt Lake Area to demonstrate whether impacts of road salting can be determined.

4) Outline a plan that may be implemented by UDOT to improve management of its road salting to minimize water quality impacts.

LITERATURE SUMMARY

Based on the literature review the following summary statement was made by the authors:

"Road Salting can seriously affect surface water if environmental conditions do not allow adequate dilution and mixing of the contaminated water with water low in salinity. Serious surface water salt contamination problems are rare and site specific. Road salting has produced more detrimental effects in the Northeastern part of the United States because road salt is used more intensely in these states. The major rivers in the US do not appear to be adversely affected by salting applications due to large dilution of salt contaminated waters. Urban areas are more affected by road salting because more road salt is used and polluted water can not easily escape into the soil and it is channeled into standing surface waters".

Other findings from the study suggest that:

1) Road salt's most deleterious effects on surface water are confined mainly to small streams running adjacent to salt-treated highways. Salt loadings in larger rivers and lakes are usually diluted due to high water volume.

2) Groundwater salinity may increase due to road salting. This could decrease the acceptance of the water as a drinking or industrial water source.

3) Salts leaching through soils may cause toxic heavy metals to be removed from sorptive or exchange

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sites in the soil and be transported into ground water or surface water; and

4) Increased salinity in streams may alter the biotic makeup and food web of the aquatic ecosystem.

WATER QUALITY IN THE SALT LAKE AREA

Data was obtained from the Utah Division of Water Quality and the United States Geological Survey (USGS) for five streams in the Salt Lake Area: Big Cottonwood Creek, Little Cottonwood Creek, Mill Creek, Emigration Creek, and Red Butte Creek. The chloride concentration and transportation trends for each of these drainage areas were reviewed. Big and Little Cottonwood Creeks have similar terrain, vegetation patterns, and cultural influences that are adjacent to roads leading to major ski resorts in the Watsatch Front. Emigration Creek is much smaller than Big and Little Cottonwood Creeks and is located in a different watershed. It is also impacted by cultural influences requiring continued road salting to ensure safe traffic conditions. Millcreek Canyon is not as highly developed and requires minimal salt applications. Red Butte is unaffected by road salting and for this reason was chosen to provide a base line for average chloride concentrations.

The highest concentrations were in the winter and early spring for all streams when the flow rates were less than 2.8 m^3/s (100cfs). Mill Creek exhibited concentration rates similar to Red Butte Canyon averaging 11mg/L. Big and Little Cottonwood Canyon Creeks had concentration rates averaging 24mg/L. Emigration Creek was the highest and averaged 81mg/L with peak concentration rates as high as 284.9mg/L. The federal secondary drinking water standard (40 CFR 143) is 250mg/L. In all cases concentrations dropped significantly when flow rates were greater than 2.8 m^3/s. As long as flow rates were above the 2.8 m^3/s, the chloride concentrations remained low with no negative environmental impact. Due to cultural influences and the need for deicing operations the chloride concentration during the winter/spring period were considerably higher in Big Cottonwood, Little Cottonwood, and Emigration Creeks.

CONSIDERATIONS FOR UDOT'S MANAGEMENT OF DEICING SALTS

Numerous approaches for increasing the efficiency of deicing operations, reducing the quantities of deicing agents, and decreasing the negative environmental impacts of these agents are available:

1) Identify areas where NaCl applications should be substantially reduced or eliminated.

2) Use alternative deicers like calcium magnesium acetate (CMA) to mitigate water quality impacts.

3) Use grit and minimal amounts of salts (NaCl, $CaCl_2$, $MgCl_2$) in sensitive areas where PM_{10} emissions and curb retention of grit are not important.

4) Develop a decision support system, based on weather conditions and road conditions allowing operators to determine if deicers and/or abrasives are necessary and to select the most effective combination.

5) Train operators on selecting deicing and/or abrasive materials, how to determine optimal application rates, methods for equipment calibration, operation, and application procedures.

6) Increase reliance on plowing.

Numerous studies have been conducted documenting the impacts of road salt on the environment. As with all research these findings can be significant but are dependent on other factors as well. Each site needs to be evaluated for the quantity and timing of salt applied, local drainage features, weather conditions, soil type, topography, watershed size, vegetation cover, species composition, and distance from the roadway. Other environmental considerations, such as vehicle exhaust emissions, drought, plant diseases and pests are also likely to affect the overall picture.

*__NOTE:__ For copies of this report please contact the UDOT's Research Division and refer to Report # UT-95.08; " A Review and Synthesis of the Impacts of Road Salting on Water Quality".